SEQUENCE LISTING

<110> The Scripps Research Institute Deiters, Alexander Cropp, T Ashton Chin, Jason W Anderson, J Christopher Schultz, Peter G <120> UNNATURAL REACTIVE AMINO ACID GENETIC CODE ADDITIONS 54-000250US/PC <130> <160> 104 <170> PatentIn version 3.3 <210> 1 1275 <211> <212> DNA <213> Escherichia coli <400> 60 atggcaagca gtaacttgat taaacaattg caagagcggg ggctggtagc ccaggtgacg 120 gacgaggaag cgttagcaga gcgactggcg caaggcccga tcgcgctcta ttgcggcttc gatcctaccg ctgacagctt gcatttgggg catcttgttc cattgttatg cctgaaacgc 180 240 ttccagcagg cgggccacaa gccggttgcg ctggtaggcg gcgcgacggg tctgattggc 300 gacccgagct tcaaagctgc cgagcgtaag ctgaacaccg aagaaactgt tcaggagtgg gtggacaaaa tccgtaagca ggttgccccg ttcctcgatt tcgactgtgg agaaaactct 360 420 gctatcgcgg cgaacaacta tgactggttc ggcaatatga atgtgctgac cttcctgcgc 480 gatattggca aacacttctc cgttaaccag atgatcaaca aagaagcggt taagcagcgt 540 ctcaaccgtg aagatcaggg gatttcgttc actgagtttt cctacaacct gttgcagggt 600 tatgacttcg cctgtctgaa caaacagtac ggtgtggtgc tgcaaattgg tggttctgac 660 cagtggggta acatcacttc tggtatcgac ctgacccgtc gtctgcatca gaatcaggtg 720 tttggcctga ccgttccgct gatcactaaa gcagatggca ccaaatttgg taaaactgaa ggcggcgcag tctggttgga tccgaagaaa accagcccgt acaaattcta ccagttctgg 780 atcaacactg cggatgccga cgtttaccgc ttcctgaagt tcttcacctt tatgagcatt 840 900 gaagagatca acgccctgga agaagaagat aaaaacagcg gtaaagcacc gcgcgcccag tatgtactgg cggagcaggt gactcgtctg gttcacggtg aagaaggttt acaggcggca 960 1020 aaacgtatta ccgaatgcct gttcagcggt tctttgagtg cgctgagtga agcggacttc 1080 gaacagctgg cgcaggacgg cgtaccgatg gttgagatgg aaaagggcgc agacctgatg caggcactgg tcgattctga actgcaacct tcccgtggtc aggcacgtaa aactatcgcc 1140 1200 tccaatgcca tcaccattaa cggtgaaaaa cagtccgatc ctgaatactt ctttaaagaa 1260 gaagatcgtc tgtttggtcg ttttacctta ctgcgtcgcg gtaaaaagaa ttactgtctg

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Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 305 310 315 320	
Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 325 330 335	•
Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 340 345 350	L
Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365	ι
Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380	;
Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400	
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Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 135 140

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg 145 150 155 160

Leu Asn Arg Glu Asp Gln Gly Ile Ser Phe Thr Glu Phe Ser Tyr Asn 165 170 175

Leu Leu Gln Gly Tyr Ser Met Ala Cys Leu Asn Lys Gln Tyr Gly Val 180 185 190

Val Leu Gln Ile Gly Gly Ser Asp Gln Trp Gly Asn Ile Thr Ser Gly 195 200 205

Ile Asp Leu Thr Arg Arg Leu His Gln Asn Gln Val Phe Gly Leu Thr 210 215 220

Val Pro Leu Ile Thr Lys Ala Asp Gly Thr Lys Phe Gly Lys Thr Glu 225 230 235 240

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Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 305 310 315 320	
Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 325 330 335	
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Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365	
Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380	
Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400	
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Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
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Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
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Leu	Leu	Gln	Gly 180	Tyr	Ser	Met	Ala	Cys 185	Ala	Asn	Lys	Gln	Tyr 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
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Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu

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Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser A	Ala Leu Ser 335
Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro N 340 345	Met Val Glu 350
Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp 355 360 365	Ser Glu Leu
Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser A	Asn Ala Ile
Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe 1 385 390 395	Phe Lys Glu 400
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Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe 50 55 60	Gln Gln Ala
Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly 65 70 75	Leu Ile Gly 80
Page 27	

Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
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Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
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Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
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Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser

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Lys	Arg	Ile	Thr	Glu 325	Суѕ	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
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Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 135 140													
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Leu Asn Arg Glu Asp Gln Gly Ile Ser Phe Thr Glu Phe Ser Tyr Asn 165 170 175													

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Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
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Met	Glu	Lys 355	Gly	Ala	Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
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Thr 385	Ile	Asn	Gly	Glu	Lys 390	Gln	Ser	Asp	Pro	Glu 395	Tyr	Phe	Phe	Lys	Glu 400
Glu	Asp	Arg	Leu	Phe 405	Gly	Arg	Phe	Thr	Leu 410	Leu	Arg	Arg	Gly	Lys 415	Lys
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Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Туr	Arg 270	Phe	Leu
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Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
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Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	туr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320

Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 340 345 Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 375 380 Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys Asn Tyr Cys Leu Ile Cys Trp Lys 420 <210> 45 <211> 424 <212> PRT <213> artificial <220> <223> artificial synthetase <400> 45 Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val 5 Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly Pro Ile Ala Leu Ile Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 105 100

Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu		Gly 180	Tyr	Gly	Met	Ala	Cys 185	Ala	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280		Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu	Ala	Asp	Phe 340	Glu	Gln	Leu	Ala	Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met	Glu	Lys 355	Gly	Ala	Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu

Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys Asn Tyr Cys Leu Ile Cys Trp Lys 420 <210> 46 <211> 424 <212> PRT<213> artificial <220> <223> artificial synthetase <400> 46 Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly Pro Ile Ala Leu Gly Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 60 Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 135

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg

150

155

Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Туг 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Gly	Phe	Ala	Cys 185	Ala	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu	Ala	Asp	Phe 340	Glu	Gln	Leu	Ala	Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met	Glu	Lys 355	Gly	Ala	Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
Gln	Pro 370	Ser	Arg	Gly	Gln	Ala 375	Arg	Lys	Thr	Ile	Ala 380	Ser	Asn	Ala	Ile
Thr 385	Ile	Asn	Gly	Glu	Lys 390	Gln	Ser	Asp	Pro	Glu 395	Tyr	Phe	Phe	Lys	Glu 400
Glu	Asp	Arg	Leu	Phe 405	Gly	Arg	Phe	Thr	Leu 410	Leu	Arg	Arg	Gly	Lys 415	Lys

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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n Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gl
n Gly 20 25 30

Pro Ile Ala Leu Gly Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 40 45

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 ' 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 135 140

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg 145 150 155 160

Leu Asn Arg Glu Asp Gln Gly Ile Ser Phe Thr Glu Phe Ser Tyr Asn 165 170 175

Leu Leu Gln Gly Tyr Gly Tyr Ala Cys Met Asn Lys Gln Tyr Gly Val 180 185 190

Val Leu Gln Ile Gly Gly Ser Asp Gln Trp Gly Asn Ile Thr Ser Gly 195 200 205

Ile Asp Leu 210	Thr Arg	J Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val Pro Leu 225	ı Ile Thi	230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly Gly Ala	a Val Tr 24		Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr Gln Phe	e Trp Ile 260	e Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys Phe Phe 275		e Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu Asp Lys 290	s Asn Se	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu Gln Va 305	l Thr Ar	g Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys Arg Ile	e Thr Gl		Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu Ala Ası	Phe Gl	ı Gln	Leu	Ala	Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met Glu Ly: 35!		a Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
Gln Pro Se: 370	r Arg Gl	y Gln	Ala 375	Arg	Lys	Thr	Ile	Ala 380	Ser	Asn	Ala	Ile
Thr Ile Ass 385	n Gly Gl	1 Lys 390	Gln	Ser	Asp	Pro	Glu 395	Tyr	Phe	Phe	Lys	Glu 400
Glu Asp Ar	g Leu Ph 40		Arg	Phe	Thr	Leu 410	Leu	Arg	Arg	Gly	Lys 415	Lys
Asn Tyr Cy	s Leu Il 420	e Cys	Trp	Lys							,	
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<220> <223> art	ificial	synthe	etas	e		Dа	ae 4	3				

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Ala	Gln	Val	Thr 20	Asp	Glu	Glu	Ala	Leu 25	Ala	Glu	Arg	Leu	Ala 30	Gln	Gly
Pro	Ile	Ala 35	Leu	Leu	Cys	Gly	Phe 40	Asp	Pro	Thr	Ala	Asp 45	Ser	Leu	His
Leu	Gly 50	His	Leu	Val	Pro	Leu 55	Leu	Суз	Leu	Lys	Arg 60	Phe	Gln	Gln	Ala
Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Met	Ala	Cys 185	Ala	Asn	Lys	Gln	Tyr 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr

Gly Gly Ala Val Trp Leu Asp Pro Lys Lys Thr Ser Pro Tyr Lys Phe 245 250

Val Pro Leu Ile Thr Lys Ala Asp Gly Thr Lys Phe Gly Lys Thr Glu 225 230 235 240

Tyr Gln Phe Trp Ile Asn Thr Ala Asp Ala Asp Val Tyr Arg Phe Leu Lys Phe Phe Thr Phe Met Ser Ile Glu Glu Ile Asn Ala Leu Glu Glu 280 Glu Asp Lys Asn Ser Gly Lys Ala Pro Arg Ala Gln Tyr Val Leu Ala Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 315 310 Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 330 Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 345 Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 375 370 Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys Asn Tyr Cys Leu Ile Cys Trp Lys 420 <210> 49 <211> 424 <212> PRT <213> artificial <220> <223> artificial synthetase <400> 49

Pro Ile Ala Leu Val Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His Page 45

Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val

Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly

5

15

Leu	Gly 50	His	Leu	Val	Pro	Leu 55	Leu	Cys	Leu	Lys	Arg 60	Phe	Gln	Gln	Ala
Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Ala	Ala	Cys 185	Ala	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala

Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 310 Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 325 330 Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 395 Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 Asn Tyr Cys Leu Ile Cys Trp Lys 420 <210> 50 <211> 424 <212> PRT <213> artificial <220> <223> artificial synthetase <400> 50 Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly Pro Ile Ala Leu Leu Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 40 Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 55 Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 75 70 65

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr

85	90	95

Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155		Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Туг 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Ala	Ala	Cys 185	Ala	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu	Ala	Asp	Phe 340	Glu	Gln	Leu	Ala	Gln 345		Gly ge 4		Pro	Met 350	Val	Glu

Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365

Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380

Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400

Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 410 415

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly
20 25 30

Pro Ile Ala Leu Val Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 40 45

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys Page 49 130 135 140

His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Ala	Ala	Cys 185	Val	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu	Ala	Asp	Phe 340	Glu	Gln	Leu	Ala	Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met	Glu	Lys 355	Gly	Ala	Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
Gln	Pro 370	Ser	Arg	Gly	Gln	Ala 375	Arg	Lys	Thr	Ile	Ala 380	Ser	Asn	Ala	Ile
Thr 385	Ile	Asn	Gly	Glu	Lys 390	Gln	Ser	Asp		Glu 395 ge 5		Phe	Phe	Lys	Glu 400

Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 410 415

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val 1 5 10 15

Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly 20 25 30

Pro Ile Ala Leu Ile Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 40 45

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asp Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 135 140

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg 145 150 155 160

Leu Asn Arg Glu Asp Gln Gly Ile Ser Phe Thr Glu Phe Ser Tyr Asn 165 170 175

Leu Leu Gln Gly Tyr Asn Phe Ala Cys Val Asn Lys Gln Tyr Gly Val Page 51 Val Leu Gln Ile Gly Gly Ser Asp Gln Trp Gly Asn Ile Thr Ser Gly 195 200 205

Ile Asp Leu Thr Arg Arg Leu His Gln Asn Gln Val Phe Gly Leu Thr 210 215 220

Val Pro Leu Ile Thr Lys Ala Asp Gly Thr Lys Phe Gly Lys Thr Glu 225 230 235 240

Gly Gly Ala Val Trp Leu Asp Pro Lys Lys Thr Ser Pro Tyr Lys Phe 245 250 255

Tyr Gln Phe Trp Ile Asn Thr Ala Asp Ala Asp Val Tyr Arg Phe Leu 260 265 270

Lys Phe Phe Thr Phe Met Ser Ile Glu Glu Ile Asn Ala Leu Glu Glu 275 280 285

Glu Asp Lys Asn Ser Gly Lys Ala Pro Arg Ala Gln Tyr Val Leu Ala 290 295 300

Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 305 310 315 320

Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 325 330 335

Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 340 345 350

Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365

Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380

Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400

Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 410 415

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val 1 5 10 15

Ala Gl
n Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gl
n Gly 20 25 30

Pro Ile Ala Leu Thr Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His $35 \hspace{1cm} 40 \hspace{1cm} 45$

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 140

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg 145 150 155 160

Leu Asn Arg Glu Asp Gln Gly Ile Ser Phe Thr Glu Phe Ser Tyr Asn 165 170 175

Leu Leu Gln Gly Tyr Ser Ala Ala Cys Leu Asn Lys Gln Tyr Gly Val 180 185 190

Val Leu Gln Ile Gly Gly Ser Asp Gln Trp Gly Asn Ile Thr Ser Gly
195 200 205

Ile Asp Leu Thr Arg Arg Leu His Gln Asn Gln Val Phe Gly Leu Thr 210 215 220

Val Pro Leu Ile Thr Lys Ala Asp Gly Thr Lys Phe Gly Lys Thr Glu Page 53 Gly Gly Ala Val Trp Leu Asp Pro Lys Lys Thr Ser Pro Tyr Lys Phe 245 250 255

Tyr Gln Phe Trp Ile Asn Thr Ala Asp Ala Asp Val Tyr Arg Phe Leu 260 265 270

Lys Phe Phe Thr Phe Met Ser Ile Glu Glu Ile Asn Ala Leu Glu Glu 275 280 285

Glu Asp Lys Asn Ser Gly Lys Ala Pro Arg Ala Gln Tyr Val Leu Ala 290 295 300

Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 305 310 315 320

Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 325 330 335

Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 340 345 350

Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365

Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380

Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400

Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 410 415

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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Pro	Ile	Ala 35	Leu	Gly	Cys	Gly	Phe 40	Asp	Pro	Thr	Ala	Asp 45	Ser	Leu	His
Leu	Gly 50	His	Leu	Val	Pro	Leu 55	Leu	Cys	Leu	Lys	Arg 60	Phe	Gln	Gln	Ala
Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Туг 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Met	Ala	Cys 185	Leu	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe	Thr	Phe	Met	Ser	Ile	Glu	Glu	Ile	Asn	Ala	Leu	Glu	Glu

275 280 285

Glu Asp Lys Asn Ser Gly Lys Ala Pro Arg Ala Gln Tyr Val Leu Ala 290 295 300

Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala 305 310 315 320

Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 325 330 335

Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 340 345 350

Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365

Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380

Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400

Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 410 415

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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n Gly 20 25 30

Pro Ile Ala Leu Thr Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His $35 \hspace{1cm} 40 \hspace{1cm} 45$

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Ala	Ala	Cys 185	Leu	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu	Cys	Leu	Phe	Ser	Gly	Ser	Leu	Ser	Ala	Leu	Ser

325 330 335

Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu 340 345 350

Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 365

Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 370 375 380

Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400

Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 405 410 415

Asn Tyr Cys Leu Ile Cys Trp Lys 420

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Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Туг 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Thr	Met	Ala	Cys 185	Val	Asn	Lys	Gln	туr 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu	Ala	Asp	Phe 340	Glu	Gln	Leu	Ala	Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met	Glu	Lys 355	Gly	Ala	Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
Gln	Pro	Ser	Arg	Gly	Gln	Ala	Arg	Lys		Ile ge 5		Ser	Asn	Ala	Ile

370 375 380

Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 400

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Pro Ile Ala Leu Ala Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 40 45

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys 130 135 140

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg 145 150 155 160

Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Tyr	Ala	Cys 185	Leu	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly 、
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala
Glu 305	Gln	Val	Thr	Arg	Leu 310	Val	His	Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys	Arg	Ile	Thr	Glu 325	Cys	Leu	Phe	Ser	Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu	Ala	Asp	Phe 340	Glu	Gln	Leu	Ala	Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met	Glu	Lys 355	Gly	Ala	Asp	Leu	Met 360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
Gln	Pro 370	Ser	Arg	Gly	Gln	Ala 375	Arg	Lys	Thr	Ile	Ala 380	Ser	Asn	Ala	Ile
Thr 385	Ile	Asn	Gly	Glu	Lys 390	Gln	Ser	Asp	Pro	Glu 395	Tyr	Phe	Phe	Lys	Glu 400
Glu	Asp	Arg	Leu	Phe 405	Gly	Arg	Phe	Thr	Leu 410	Leu	Arg	Arg	Gly	Lys 415	Lys
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Pro Ile Ala Leu Ala Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 40 45

Leu Gly His Leu Val Pro Leu Leu Cys Leu Lys Arg Phe Gln Gln Ala 50 55 60

Gly His Lys Pro Val Ala Leu Val Gly Gly Ala Thr Gly Leu Ile Gly 65 70 75 80

Asp Pro Ser Phe Lys Ala Ala Glu Arg Lys Leu Asn Thr Glu Glu Thr 85 90 95

Val Gln Glu Trp Val Asp Lys Ile Arg Lys Gln Val Ala Pro Phe Leu 100 105 110

Asp Phe Asp Cys Gly Glu Asn Ser Ala Ile Ala Ala Asn Asn Tyr Asp 115 120 125

Trp Phe Gly Asn Met Asn Val Leu Thr Phe Leu Arg Asp Ile Gly Lys
130 135 140

His Phe Ser Val Asn Gln Met Ile Asn Lys Glu Ala Val Lys Gln Arg 145 150 155 160

Leu Asn Arg Glu Asp Gln Gly Ile Ser Phe Thr Glu Phe Ser Tyr Asn 165 170 175

Leu Leu Gln Gly Tyr Thr Met Ala Cys Cys Asn Lys Gln Tyr Gly Val 180 185 190

Val Leu Gln Ile Gly Gly Ser Asp Gln Trp Gly Asn Ile Thr Ser Gly 195 200 . 205

Ile Asp Leu 210	Thr Arg	Arg Leu 215	His (Gln Asr	ı Gln	Val 220	Phe	Gly	Leu	Thr
Val Pro Leu 225	Ile Thr	Lys Ala 230	Asp (Gly Thi	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly Gly Ala	Val Trp 245	Leu Asp	Pro I	Lys Lys 25(Ser	Pro	Tyr	Lys 255	Phe
Tyr Gln Phe	Trp Ile 260	Asn Thr		Asp Ala 265	a Asp	Val	Tyr	Arg 270	Phe	Leu
Lys Phe Phe 275	Thr Phe	Met Ser	Ile (Glu Glı	ılle	Asn	Ala 285	Leu	Glu	Glu
Glu Asp Lys 290	Asn Ser	Gly Lys 295	Ala I	Pro Arg	g Ala	Gln 300	Tyr	Val	Leu	Ala
Glu Gln Val 305	Thr Arg	Leu Val 310	His (Gly Glı	ı Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys Arg Ile	Thr Glu 325	Cys Leu	Phe S	Ser Gly 330		Leu	Ser	Ala	Leu 335	Ser
Glu Ala Asp	Phe Glu 340	Gln Leu		Gln Ası 345	Gly	Val	Pro	Met 350	Val	Glu
Met Glu Lys 355	Gly Ala	Asp Leu	Met (Gln Ala	a Leu	Val	Asp 365	Ser	Glu	Leu
Gln Pro Ser 370	Arg Gly	Gln Ala 375	Arg 1	Lys Th	r Ile	Ala 380	Ser	Asn	Ala	Ile
Thr Ile Asn 385	Gly Glu	Lys Gln 390	Ser i	Asp Pro	o Glu 395	Tyr	Phe	Phe	Lys	Glu 400
Glu Asp Arg	Leu Phe 405	Gly Arg	Phe '	Thr Let		Arg	Arg	Gly	Lys 415	Lys
Asn Tyr Cys	Leu Ile 420	Cys Trp	Lys							
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Pro	Ile	Ala 35	Leu	Thr	Cys	Gly	Phe 40	Asp	Pro	Thr	Ala	Asp 45	Ser	Leu	His
Leu	Gly 50	His	Leu	Val	Pro	Leu 55	Leu	Суѕ	Leu	Lys	Arg 60	Phe	Gln	Gln	Ala
Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Tyr 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Thr	Phe	Ala	Cys 185	Met	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe

275 280 Glu Asp Lys Asn Ser Gly Lys Ala Pro Arg Ala Gln Tyr Val Leu Ala 295 Glu Gln Val Thr Arg Leu Val His Gly Glu Glu Gly Leu Gln Ala Ala Lys Arg Ile Thr Glu Cys Leu Phe Ser Gly Ser Leu Ser Ala Leu Ser 330 Glu Ala Asp Phe Glu Gln Leu Ala Gln Asp Gly Val Pro Met Val Glu Met Glu Lys Gly Ala Asp Leu Met Gln Ala Leu Val Asp Ser Glu Leu 355 360 Gln Pro Ser Arg Gly Gln Ala Arg Lys Thr Ile Ala Ser Asn Ala Ile 375 370 Thr Ile Asn Gly Glu Lys Gln Ser Asp Pro Glu Tyr Phe Phe Lys Glu 385 390 395 Glu Asp Arg Leu Phe Gly Arg Phe Thr Leu Leu Arg Arg Gly Lys Lys 410 Asn Tyr Cys Leu Ile Cys Trp Lys 420 <210> 60 <211> 424 <212> PRT <213> artificial <220> <223> artificial synthetase <400> 60 Met Ala Ser Ser Asn Leu Ile Lys Gln Leu Gln Glu Arg Gly Leu Val Ala Gln Val Thr Asp Glu Glu Ala Leu Ala Glu Arg Leu Ala Gln Gly 20 25 Pro Ile Ala Leu Thr Cys Gly Phe Asp Pro Thr Ala Asp Ser Leu His 35 Page 65

Tyr Gln Phe Trp Ile Asn Thr Ala Asp Ala Asp Val Tyr Arg Phe Leu 260 265 270

Lys Phe Phe Thr Phe Met Ser Ile Glu Glu Ile Asn Ala Leu Glu Glu

Leu	Gly 50	His	Leu	Val	Pro	Leu 55	Leu	Cys	Leu	Lys	Arg 60	Phe	Gln	Gln	Ala
Gly 65	His	Lys	Pro	Val	Ala 70	Leu	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp	Pro	Ser	Phe	Lys 85	Ala	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr
Val	Gln	Glu	Trp 100	Val	Asp	Lys	Ile	Arg 105	Lys	Gln	Val	Ala	Pro 110	Phe	Leu
Asp	Phe	Asp 115	Cys	Gly	Glu	Asn	Ser 120	Ala	Ile	Ala	Ala	Asn 125	Asn	Tyr	Asp
Trp	Phe 130	Gly	Asn	Met	Asn	Val 135	Leu	Thr	Phe	Leu	Arg 140	Asp	Ile	Gly	Lys
His 145	Phe	Ser	Val	Asn	Gln 150	Met	Ile	Asn	Lys	Glu 155	Ala	Val	Lys	Gln	Arg 160
Leu	Asn	Arg	Glu	Asp 165	Gln	Gly	Ile	Ser	Phe 170	Thr	Glu	Phe	Ser	Туг 175	Asn
Leu	Leu	Gln	Gly 180	Tyr	Ser	Val	Ala	Cys 185	Leu	Asn	Lys	Gln	Туг 190	Gly	Val
Val	Leu	Gln 195	Ile	Gly	Gly	Ser	Asp 200	Gln	Trp	Gly	Asn	Ile 205	Thr	Ser	Gly
Ile	Asp 210	Leu	Thr	Arg	Arg	Leu 215	His	Gln	Asn	Gln	Val 220	Phe	Gly	Leu	Thr
Val 225	Pro	Leu	Ile	Thr	Lys 230	Ala	Asp	Gly	Thr	Lys 235	Phe	Gly	Lys	Thr	Glu 240
Gly	Gly	Ala	Val	Trp 245	Leu	Asp	Pro	Lys	Lys 250	Thr	Ser	Pro	Tyr	Lys 255	Phe
Tyr	Gln	Phe	Trp 260	Ile	Asn	Thr	Ala	Asp 265	Ala	Asp	Val	Tyr	Arg 270	Phe	Leu
Lys	Phe	Phe 275	Thr	Phe	Met	Ser	Ile 280	Glu	Glu	Ile	Asn	Ala 285	Leu	Glu	Glu
Glu	Asp 290	Lys	Asn	Ser	Gly	Lys 295	Ala	Pro	Arg	Ala	Gln 300	Tyr	Val	Leu	Ala

Glu Gln V 305	al Thr	Arg Leu 310	Val H	His (Gly	Glu	Glu 315	Gly	Leu	Gln	Ala	Ala 320
Lys Arg I	le Thr	Glu Cys 325	Leu I	Phe S		Gly 330	Ser	Leu	Ser	Ala	Leu 335	Ser
Glu Ala A	sp Phe 340	Glu Gln	Leu A		Gln 345	Asp	Gly	Val	Pro	Met 350	Val	Glu
Met Glu L 3	ys Gly 55	Ala Asp		Met (360	Gln	Ala	Leu	Val	Asp 365	Ser	Glu	Leu
Gln Pro S 370	er Arg	Gly Gln	Ala 2 375	Arg 1	Lys	Thr	Ile	Ala 380	Ser	Asn	Ala	Ile
Thr Ile A	sn Gly	Glu Lys 390	Gln s	Ser 2	Asp	Pro	Glu 395	Tyr	Phe	Phe	Lys	Glu 400
Glu Asp A	arg Leu	Phe Gly 405	Arg 1	Phe '	Thr	Leu 410	Leu	Arg	Arg	Gly	Lys 415	Lys
Asn Tyr C	ys Leu 420	Ile Cys	Trp I	Lys								1
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Ala Gln V	al Thr 20	Asp Glu	Glu i		Leu 25	Ala	Glu	Arg	Leu	Ala 30	Gln	Gly
Pro Ile A	ala Leu 35	Val Cys		Phe 40	Asp	Pro	Thr	Ala	Asp 45	Ser	Leu	His
Leu Gly F 50	His Leu	Val Pro	Leu :	Leu	Cys	Leu	Lys	Arg 60	Phe	Gln	Gln	Ala
Gly His I 65	Lys Pro	Val Ala 70	Leu '	Val	Gly	Gly	Ala 75	Thr	Gly	Leu	Ile	Gly 80
Asp Pro S	Ser Phe	Lys Ala 85	Ala	Glu	Arg	Lys 90	Leu	Asn	Thr	Glu	Glu 95	Thr

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